

Special Summary Report (Session II)

Effects of Climate Change on Marine, Land And Mountainous Areas in Kuroshio-Related Countries

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Abstract

Under the theme of "climate change", seven speakers presented respective topics based mainly on their case studies conducted in Japan, Taiwan, the Philippines and Vietnam at the 5th Kuroshio Symposium. As is shown in each report, there exist diverse means of shedding light on this over-arching theme, as climate change is closely integrated with global warming and/or global change. The seven topics covered a wide range, from the impact of increasing ocean surface temperatures, to the effects on tropical rainforests. Throughout this session, we attempted to understand the present situation based on scientific evidence. Each speaker presented their survey/research outputs relating to climate change in order to exchange views on how to address from a scientific standpoint and discuss various problems that occur beyond national boundaries in the Kuroshio Region.

Key words: climate change, global change, global warming, Kuroshio Region

1. Introduction

At the Kaohsiung Conference, the keynote theme of climate change was reviewed by seven



Fig.1. Kuroshio-related countries and areas targeted in case studies

speakers during the first session (Fig.1). In this session, the definition of climate change, its global impacts on the earth as a whole, and international efforts being undertaken to mitigate the effects of greenhouse gases had been previously covered and were not be discussed in detail. We focused on how we are able to adapt to and/or cope with various circumstances brought about by climate change, such as increasing atmospheric temperature, unprecedented heavy rains, and super typhoons that are becoming increasingly severe in the Kuroshio Region.

Prior to the presentations in this session, the chairpersons gave introductory remarks, including the reasons for which climate change was selected as the main theme. Through internal meetings conducted thus far among the collaborating organizations, most counterparts under the Kuroshio Triangle region stated that they placed utmost priority on studies on climate change, especially for subjects related to the deterioration of coastal environments (Fig.2).

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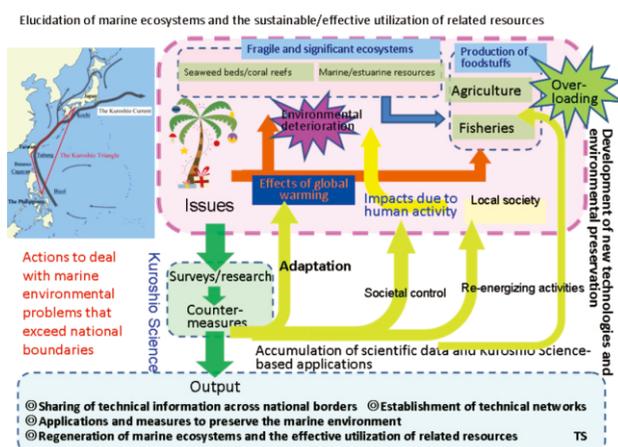


Fig.2. Conceptual chart of collaborative studies in Kuroshio-related areas

This is also the case with universities in Malaysia and Indonesia, with the addition of concern over the deterioration of tropical rainforests. Taking into account our research priorities, we selected themes focusing on climate change so that we could exchange viewpoints based on research output. For example, increasing atmospheric and ocean surface temperatures influence the environment in various ways. This session aimed to reveal the actual situations existing at differing places in Kuroshio-related areas, in order to allow reflection upon insights derived from discussion, and to promote further collaborative studies.

1. Marine ecosystems under global warming

1) Case study in Kochi Prefecture, Japan

The first speaker, Dr. Yohei Nakamura (Kochi University), illustrated an example from the coastal regions of Kochi Prefecture. His topic was: "Impact of climate change on temperate marine ecosystems in Japan". He showed how global warming disrupts marine biodiversity and ecosystems as well as affect coastal fisheries around Tosa Bay in Kochi.

The surface seawater temperatures (SSTs) in Tosa Bay during winter (January-March) have rapidly increased in the past 30 years, and species belonging to the coastal habitat-forming *Sargassum* have been changing from temperate to tropical species. Although the temporal vegetation pattern differed between algal species in Tosa Bay, thalli of the latter being unavailable during autumn and winter, high recruitment of fishes matched the peak of biomass of both algae from late spring to early summer (May-July).

At present, there is no evidence that tropical

algal invasion has negatively affected the temperate fish assemblages and coastal fisheries. Drifting algae (*Sargassum*) occur at the offshore during March-August in Tosa Bay. The juvenile of the yellowtail (*Seriola quinqueradiata*), which is used as an aquaculture seed stock, is frequently associated with drifting algae during March-May in the bay. Tropical *Sargassum* species are harder to detach from the seafloor by ocean waves compared to temperate *Sargassum* species, suggesting that the decrease in temperate algae in the temperate coasts may negatively affect aquaculture seed stock fisheries.

Tropical reef coral expansion occurs in shallow rocky reef in Tosa Bay (Fig.3). Comparative



Fig.3. A view of the ocean from Kashiwajima Island in the western part of Kochi Prefecture

study of fish assemblage structures between rocky and coral-dominated reefs in the bay predicted that coral expansion may lead to a decrease in temperate fishes and an increase in tropical/subtropical fishes including commercial species (e.g., species of Scaridae, Acanthuridae, and Serranidae). Moreover, increase in SSTs during winter has allowed tropical fishes to survive during winter, and some adult size individuals have been observed in the bay, suggesting the presence of reproductively active fishes. Overall, global warming is expected to positively or negatively affect coastal ecosystems and fisheries in Tosa Bay. Although biological responses to global warming are not straightforward and several anthropogenic effects (e.g., over-exploitation, habitat degradation) are reducing resistance of marine ecosystems to climate change, we need to contemplate and develop an adaptation policy that would minimize the effects of climate change on marine ecosystems and fisheries in future.

2) Case study in temperate and sub-tropical waters

The second speaker, Dr. Allen Chen (Academia Sinica), presented a topic entitled "Resistance and resilience of coral communities in the high-latitude Japan: The role of Taiwan", based on the intensive field observations by his group. Dr. Chen clearly outlined that coral reef ecosystems are under the impact of climate change. Two major impacts, rising seawater temperature, and ocean acidification, were considered in this presentation. The West Pacific containing the Philippine-Japan archipelago is the home of several different types of coral communities, including tropical coral reefs, subtropical coral communities, and outlying non-reef communities. These communities may respond to rising temperatures and ocean acidification differently due to differing degrees of resistance and resilience of corals in these regions. In particular, the marginal coral communities need to be studied in terms of, for example, "will /have tropical corals migrate/migrated to the high latitudinal marginal coral communities in response to the climate change? If yes, what is the consequence of shifting species composition in the marginal reef through time? Will the new migrants out-compete with the endemic species in the high latitude causing local extinction of those species?, and how about the response of Symbiodinium?".

As Taiwan is located at a unique "stepping-stone" position along the Philippine-Japan Archipelago, approaches such as genetic connectivity, species phylogeny of rare and endemic coral species and their symbionts, physiological experiments (temperature and acidification) on coral holobionts across tropical, subtropical, and outlying temperate coral communities, and long-term ecological and community research from Philippine toward high-latitude Japan, can be taken through joint efforts among the institutes along the Kuroshio Current. In this presentation, preliminary results on the coral and Symbiodinium phylogeography along the Kuroshio Current were discussed, and the importance of networking scientists in this region were highlighted.

3) Case study on Cat Ba Island, Vietnam

As the third speaker, we invited Dr. Nguen V. Quan (Institute of Marine Environment and

Resources) from Haiphong City. He is jointly carrying out a collaborative study with NSYS (National Sun Yat-sen University) in Taiwan and gave a presentation on "Current status of the marine ecosystems and their vulnerability under the climate change impacts in the Cat Ba world biosphere reserve in the northern part of Vietnam".

The Cat Ba Islands have been considered as a world biosphere reserved by UNESCO due to its spectacular landscape and invaluable characteristics of terrestrial and marine ecosystems (Fig.4).



Fig.4. A view of Cat Ba Island in northern Vietnam

The marine ecosystems surrounding Cat Ba Islands consist of three key ecosystems such as coral reefs, mangrove forest and seagrass beds. They serve as crucial habitats for 1,357 associated marine species and contribute marine ecosystem services for local communities.

Yet, there are several threats on the health of marine ecosystems in this region; climate change has been rated as the critical impact in relation with the abnormal weather conditions (fresh water runoff due to heavy rain, sea surface temperature increasing, saline intrusion, coastal erosion, etc.). According to the climate change scenarios, the sea level rise in this area may reach 65cm up to 100cm and the sea surface temperature increase from 1.6 - 3.5°C. If these scenarios come true, the consequences will be damaging to the marine ecosystems in several ways

The tendency of reduction in the live coral coverage of 50% from 1999 - 2004 was related to the white worldwide coral bleaching phenomenon of 1997 - 1998 (abnormal sea surface water increased) or changes that occurred in the hard coral communities where the coral branching colonies have been replaced by the massive coral colonies. In recent years, saline intrusion in combination with coastal erosion lead to the reduction of mangrove areas with the ratio of 1 - 2

ha/year and negative changes also occurred in the breeding grounds for the marine species associated with the existing mangrove trees. For the seagrass beds, the sea level rise directly impacted on specific areas where the seagrass normally can be found at the intertidal or low tide areas. This generally prevents the photosynthesis processes in marine plants and buries the seagrass on the muddy layers. Thus, the seagrass beds in the Cat Ba islands may be in danger of extinction in the near future as well.

2. Socio-economic aspects and climate change

1) Case study on Yoron Island, Kagoshima Prefecture

The fourth speaker, Dr. Teruyuki Shinbo (Kochi University), has conducted studies on Yoron Island, which is situated in Kagoshima Prefecture almost exactly in the center of the Kuroshio Triangle. He presented a part of his results of a comprehensive study relating to how local governments work together with residents to conserve marine-based ecosystems under global warming. His topic was: "Adaptation to climate change by rural communities: An approach to coral reef conservation and rehabilitation on Yoron Island, Japan".

There exists much concern surrounding the serious impact of increasing ocean surface temperatures on coral reefs amid the global warming crisis (Fig.5). It is widely recognized that most

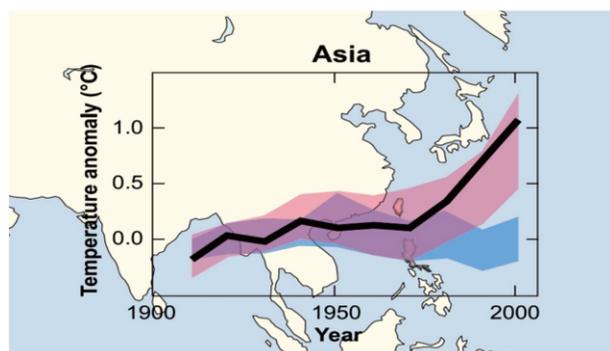


Fig.5. Temperature (atmospheric and oceanic) changes in Asia (IPPC)

factors that have brought about this situation may be attributed to anthropological activities. Dr. Shinbo and his group have conducted collaborative case studies in order to determine measures which may help mitigate such impact, and guide local people to adopt certain household and/or economic activities effective in dealing with global warming.

As an example of the above work, a survey was carried out on Yoron Island which is located within the route of the Kuroshio Current in Kagoshima Prefecture. In the ocean area surrounding this island, coral reefs had been seriously damaged mainly due to the "white syndrome" which occurred widely in this area during 1997-1998. However, due to extensive efforts made by the residents of Yoron Island, the damaged coral reefs are gradually recovering.

As is widely known, although climate change influences various aspects of coral reefs in almost all sea areas, in many cases, such impact is the result of complex, integrated factors, both natural and anthropogenic. According to the survey results conducted on Yoron Island, it was revealed that the coral reef areas are likely affected by economic activities, mainly related to agriculture and animal husbandry occurring on the island. Fertilizers and animal manure eluting from land into the sea had brought about a condition where the water was saturated with nutrients, such that the growth of surrounding coral reefs was adversely affected. In order to address this problem, island residents have been making efforts to moderate this damage by adjusting farming methods. In Dr. Shinbo's report, the adaptation of proper fertilizer usage and cropping systems, as well as the introduction of manure treatment facilities through collaborative efforts among island residents, municipal officers and researchers, were introduced.

2) Case study in a brackish water area in Cagayan, Philippines

The fifth speaker was Dr. Reynaldo Ame (AMA Univ. in Bahrain), who has studied the brackish water areas of Cagayan State in northern Luzon. Dr. Ame has looked at nippa plantations and how climate change has brought about impact on the nippa-based production system as well as what effects are generated on the local village economy. The title of his presentation was: "Climate change resiliency and the socio-economic status of rural community depending on Nypa Mangrove in Cagayan".

The Province of Cagayan which is located in the Northern tip of Luzon Island, the biggest island of the Philippines, is frequently affected by weather disturbances every year, not only by typhoons, but

also by drought. These two major manifestations of climate change do not spare the province yearly whose major sources of income come from agriculture and fisheries. An average of 10-13 typhoons visited the province with about 2-4 bringing damage to the country's agriculture and fisheries industries. Directly hit by these typhoons that are observed to be getting stronger every year and irregular in occurrences are always the coastal areas of the province in which the poor villages are located. Coping with the damages brought by these typhoons are always the problem of the rural communities.

This study looked into the socio-economic status of communities depending on Nypa mangrove and how they cope up with the climate change. The study made use of questionnaire, interviews, field visits following a specific transect, focus group discussion, timelines and daily activity monitoring to gather information about the resiliency of the rural community.

One of the findings was that the community now consists of older people and children. The young adult is getting smaller in number because of the attraction of opportunities in the city and working outside the country. Those that remain are involved in various occupations. During the typhoon months they fish in the flooded rice fields, and during drought they fish in the sea. In between, the nypa provides livelihood for them. The nypa mangrove not only provides income from the products that are directly derived from the palm, but also from the fishery products that the nypa mangrove provides.

Climate change has pushed the rural community in the area to indiscriminately use the coastal and nypa mangrove resources to their economic advantage, putting these critical resources to unsustainably provide sustenance to the livelihood of the rural community. Government intervention is wanting in the locality, especially in consideration of nypa as a critical commodity to be supported and developed to maintain its role as protector of the coast and to maintain good ecological balance for fishery products diversity in the locality.

3. Adaptation in land areas to climate change

1) Case study in an agrarian sector in the Philippines

The sixth speaker, Dr. Ninfa Pelea (Bicol University), reported on her studies focusing on the phenomena of heavy rains and typhoons and the damage they have wrought in the Philippines. Dr. Pelea shed light on how the Philippines is integrating studies on climate change with technological development, and what measures are being taken to protect agriculture and fisheries endeavors. The topic was: "Science and technology (S&T): Enhancing climate change adaptation of the Agriculture and Natural Resource Sectors in Bicol Region, Philippines".

The Philippines, because of its location, has long been identified as one of the world's countries most vulnerable to climate change. For this reason, agriculture, forestry, and natural resources (AFNR) is considered to be one of the Philippines' most vulnerable sectors. As well, the effects of climate change on the AFNR sector is being gradually manifested with predicted dire consequences to food security and the population's well-being. In response, the scientific community has put climate change on the agenda and has vigorously pursued the development of adaptive sciences and technologies that will address the effects of the phenomenon. Nevertheless, significant projects and initiatives have been long-implemented in the past. The results of such works are veritable sources of knowledge and know-how, and should therefore be made available in order to be of optimum value to the scientific and the general AFNR sector.

With respect to this viewpoint, a conference on climate change adaptation science and technology for the AFNR sector was held in Legazpi in October 2009. Some of the results present herein have shown that a low level of technology adaptation, low productivity, and general poverty are interlinked factors contributing to the situation. Thus, the Bicol Consortium for AFNR and Resources Research and Development (BCARRD) has embarked on the enhanced utilization of science and technology-based interventions as a long-term strategy in addressing the problem. In Dr. Pelea's report, an outline of programs on climate change adaptation conducted by the BCARRD, and projects for the AFNR sector were introduced together with the risk-to-climate disaster map produced by the Center for Environmental Geomatics of Manila in 2005.

2) Case study in a tropical rainforest in Sarawak, Malaysia

Finally, Dr. Mohd. Effendi Wasli (Malaysia Sarawak University), presented his studies on rainforests in Sarawak State in Malaysia. He gave a brief review of their scientific efforts in regenerating the tropical rainforest of Sarawak. Due to the current changes in land use systems in Sarawak, climate change is being given foremost priority as an urgent subject to be jointly addressed by the government, universities, and the private sector. Tropical rainforest deforestation adversely affects global efforts to stabilize greenhouse gas (GHG) concentrations and to avoid serious interference in the climate system. The need to recover forest resources with the goal of rehabilitating decreasing tropical rainforest areas is one of the major concerns in moderating global climate change. Reforesting such areas is indispensable to prevent further degradation and loss of biodiversity in tropical rainforest ecosystems (Fig. 6).

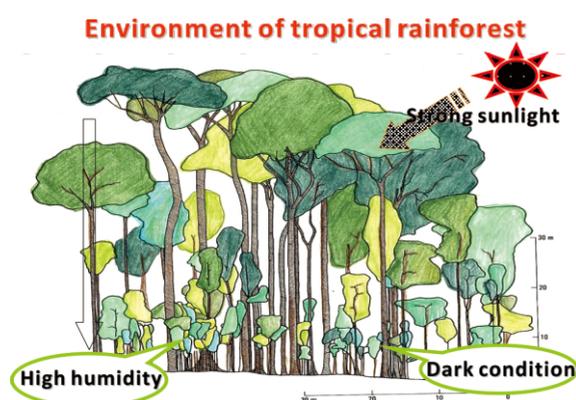


Fig.6. Towards the rehabilitation of tropical rainforests in Sarawak, Malaysia

As an option, reforestation based on plantation forestry of indigenous tree species is important not only to decrease the pressure of deforestation on natural forests, but also to restore degraded soils caused by deforestation. Here, Dr. Effendi and a colleague presented some of their current research works in regenerating tropical rainforests through the reforestation of indigenous tree species in Sarawak, Malaysia. This included analysis of the ecological features of the area under reforestation, especially on the plant-soil relationship, in order to determine whether the planted trees are suitable planting materials for future reforestation activities. In addition, as indigenous tree species

are known for their poor flowering frequency, alternative methods in plant propagation that yield planting stocks of sufficient quality to ensure the success of reforestation activities, were also discussed.

4. Discussion

Under the theme of "climate change", seven speakers presented respective topics based mainly on their case studies conducted in Japan, Taiwan, the Philippines and Vietnam. As is shown in each report, there exist diverse means of shedding light on this over-arching theme, as climate change is closely integrated with global warming and/or global change. The seven topics covered a wide range, from the impact of increasing ocean surface temperatures, to the effects on tropical rainforests. The main points of the presentations are summarized as follows:

As is shown in the section, "Marine ecosystems under global warming", it was recognized that the upwelling tendency of surface water in accordance with global warming is clearly observed not only in Japan and Taiwan, which are situated along the Kuroshio Current, but also in Vietnam. In temperate areas, seaweeds are enlarging their habitats from the south to more northern sea areas, and fishes are also migrating to new areas as well. In tropical areas, although the changes are not clear compared with those of the temperate areas, marine ecosystems are tending to deteriorate as a whole under the recent climate change. To cope with these problems, more baseline survey data relating to coastal ecosystems in conjunction with climate change are necessary.

In the section, "Socio-economic aspects and climate change", two reports shedding light on the coastal environment surrounding coral reefs and brackish water revealed that there are many subjects that need to be addressed through the modification of anthropological activities of the area residents. In addition, it was reported that at a village adjacent to a brackish water area which suffered damage due to typhoons, community-based collaborative activities played an indispensable role in the subsequent reconstruction. Both reports underlined the importance of taking countermeasures to conserve and/or protect coastal areas from environmentally-related deterioration.

In the last section, "Adaptation in land areas to climate change", two reports focused on damage due to the increasing frequency and severity of typhoons or the upwelling of sea surface levels. In addition, tropical rainforests are also deteriorating at a rather higher pace. It is noted that in coping with these circumstances, indigenous technologies prevailing in local areas must be re-evaluated as important know-how to harmonize residents' activities with natural conditions and traditional practices.

Throughout all of the all presentations, it was clearly evident that the phenomena of global warming, climate change and global change are complexly interrelated with one another. For this reason, it was difficult agree on certain points of discussion. In order to achieve greater clarity and avoid confusion, the chairpersons prepared a flowchart showing the interrelationships of the various factors relating to climate change (Fig. 7).

This flowchart was of much use in confirming what each speaker had achieved and how his/her results related to those of other topics. As shown in this flowchart, climate change presents a wide range of topics for discussion. This flowchart is expected to be useful in future situations as well. Also of note, Professor Chen-Tung Arthur Chen (NSYS University) and Professor Mituso Uematsu (University of Tokyo) provided valuable lectures as our keynote speakers, from the viewpoint of "Global Change" in this 5th Kuroshio Symposium at Kaohsiung, Taiwan.

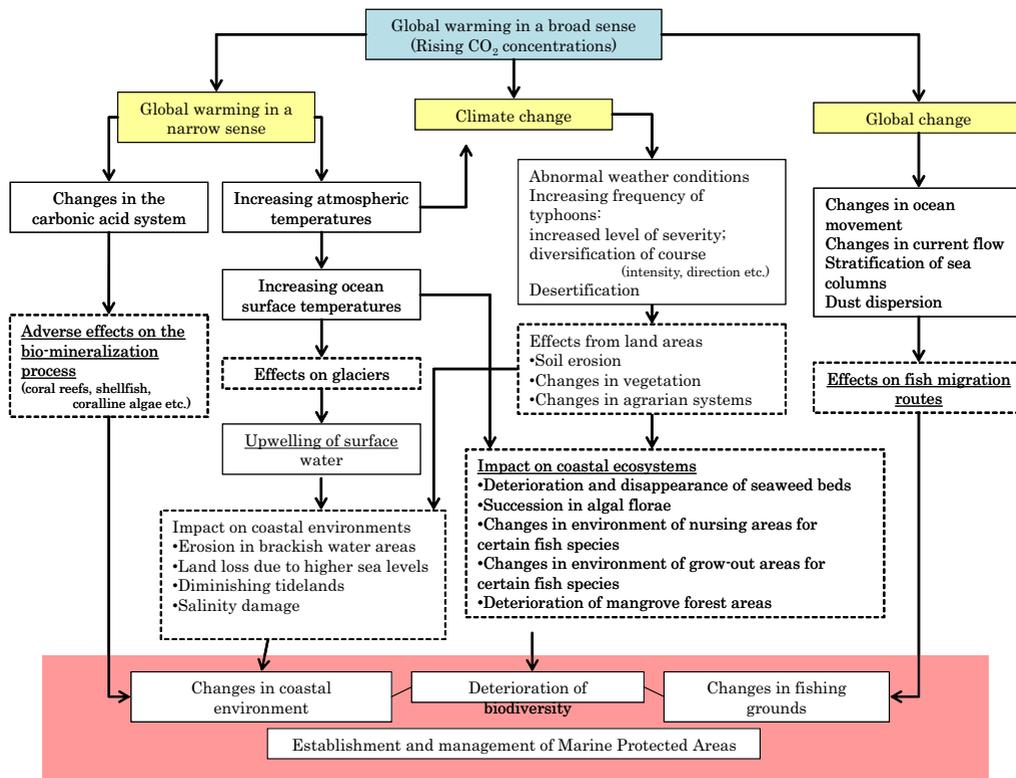


Fig.7. Flowchart showing the inter-relationships between climate change and marine/sea areas